

We claim:

1 1. A perpendicular recording write head, comprising:
2 a first and second ferromagnetic pole piece, the second pole piece with a front end
3 recessed from the ABS and magnetically connected to a back gap magnetically coupling
4 the first and second pole pieces;
5 a coil structure between the first and second ferromagnetic pole piece;
6 a write pole sub layer, formed over the second pole piece, the write pole sub layer
7 having a taper at a pole tip region toward the air bearing surface (ABS);
8 a magnetic material disposed on top of the write pole sub layer;
9 a laminated write pole layer, formed over the write pole sub layer, the laminated
10 write pole layer formed of high magnetic saturation material with interspersed non-
11 magnetic film magnetically coupled with the write pole sub layer;
12 a laminated write pole shaped from the laminated write pole layer;
13 a non-magnetic material encapsulating the write pole;
14 a ferromagnetic write shield layer disposed over the non-magnetic material
15 encapsulating the write pole; and
16 at least one ferromagnetic stud magnetically connecting the first pole piece and
17 the write shield layer.

1 2. The perpendicular recording write head of claim 1, wherein the write pole
2 further comprises a trapezoidal shape to prevent adjacent track writing when skew is
3 experienced while flying over the disk.

1 3. The perpendicular recording write head of claim 1, wherein the laminated
2 write pole includes a tapered portion.

1 4. The perpendicular recording write head of claim 1, wherein the
2 encapsulating non-magnetic material further comprises a reactive ion etchable (RIEable)
3 material.

1 5. The perpendicular recording write head of claim 4, wherein the RIEable
2 material is selected from a group of materials comprising TaO_x, SiO₂, Si₃N₄, Ta, W,
3 Al₂O₃.

1 6. The perpendicular recording write head of claim 1, further comprising a
2 write gap layer of non-magnetic materials formed on the top of the write pole layer.

1 7. The perpendicular recording write head of claim 1, further comprising an
2 overcoat deposited over the fourth stud segments and the trailing shield.

1 8. The perpendicular recording write head of claim 1, wherein the pole tip is
2 laterally surrounded by a non-magnetic material.

1 9. A magnetic head assembly that has a head surface, a read head and a
2 perpendicular recording write head, comprising:
3 the read head including:
4 ferromagnetic first and second shield layers; and
5 a read sensor located between the first and second shield layers; and
6 the perpendicular recording write head including:
7 a first and second ferromagnetic pole piece, the second pole piece with a
8 front end recessed from the ABS and magnetically connected to a back gap magnetically
9 coupling the first and second pole pieces;
10 a coil structure between the first and second ferromagnetic pole piece;
11 a write pole sub layer, formed over the second pole piece, the write pole
12 sub layer having a taper at a pole tip region toward the air bearing surface (ABS);
13 a magnetic material disposed on top of the write pole sub layer;
14 a laminated write pole layer, formed over the write pole sub layer, the
15 laminated write pole layer formed of high magnetic saturation material with interspersed
16 non-magnetic film magnetically coupled with the write pole sub layer;
17 a laminated write pole shaped from the laminated write pole layer;
18 a non-magnetic material encapsulating the write pole;
19 a ferromagnetic write shield layer disposed over the non-magnetic
20 material encapsulating the write pole; and
21 at least one ferromagnetic stud magnetically connecting the first pole piece
22 and the write shield layer.

1 10. The magnetic head assembly of claim 9, wherein the write pole further
2 comprises a trapezoidal shape to prevent adjacent track writing when skew is experienced
3 while flying over the disk.

1 11. The magnetic head assembly of claim 9, wherein the laminated write pole
2 includes a tapered portion.

1 12. The magnetic head assembly of claim 9, wherein the encapsulating non-
2 magnetic material further comprises a RIEable material.

1 13. The magnetic head assembly of claim 12, wherein the RIEable material is
2 selected from a group of materials comprising TaO_x, SiO₂, Si₃N₄, Ta, W, Al₂O₃.

1 14. The magnetic head assembly of claim 9, further comprising a write gap
2 layer of non-magnetic materials formed on the top of the write pole layer.

1 15. The magnetic head assembly of claim 9, further comprising an overcoat
2 deposited over the fourth stud segments and the trailing shield.

1 16. The magnetic head assembly of claim 9, wherein the pole tip is laterally
2 surrounded by a non-magnetic material.

1 17. A method of making a perpendicular recording write head, which has a
2 head surface comprising:
3 forming a first and second ferromagnetic pole piece, the second pole piece with a
4 front end recessed from the ABS and magnetically connected to a back gap magnetically
5 coupling the first and second pole pieces;
6 forming a coil structure between the first and second ferromagnetic pole piece;
7 forming, over the second pole piece, a write pole sub layer having a taper at a pole
8 tip region toward the air bearing surface (ABS);
9 forming a magnetic material on top of the write pole sub layer;
10 forming, over the write pole sub layer, a laminated write pole layer of high
11 magnetic saturation material with interspersed non-magnetic film magnetically coupled
12 with the write pole sub layer;
13 shaping a laminated write pole from the laminated write pole layer using reactive
14 ion etching;
15 encapsulating the write pole in a non-magnetic material;
16 forming a ferromagnetic write shield layer over the non-magnetic material
17 encapsulating the write pole; and
18 forming at least one ferromagnetic stud magnetically connecting the first pole
19 piece and the write shield layer.

1 18. The method of claim 17, wherein the shaping further comprises forming,
2 of a CMP stop layer and an ion mill mask, a hard mask layer having a shape of a desired
3 write pole on top of the laminated write pole layer and reactive ion etching laminated
4 write pole layer to form the write pole.

1 19. The method of claim 17, wherein the defining the write pole further
2 comprises shaping the write pole with a trapezoidal shape to prevent adjacent track
3 writing when skew is experienced while flying over the disk.

1 20. The method of claim 17, wherein the laminated write pole includes a
2 tapered portion.

1 21. The method of claim 17, wherein the depositing the magnetic material on
2 top of the write pole sub layer further comprises patterning a non-magnetic sacrificial
3 layer to form a write pole sub layer having a taper at a pole tip region toward the air
4 bearing surface and planarizing the magnetic material to expose the top surface of write
5 pole sub layer.

1 22. The method of claim 21, wherein the planarizing the magnetic material
2 comprises chemical mechanical polishing (CMP).

1 23. The method of claim 21, wherein the patterning the non-magnetic
2 sacrificial layer is formed by ion mill or reactive ion etching.

1 24. The method of claim 17, wherein the encapsulating the write pole in a
2 non-magnetic material further comprises using a RIEable material.

1 25. The method of claim 24, wherein the RIEable material is selected from a
2 group of materials comprising TaO_x, SiO₂, Si₃N₄, Ta, W, Al₂O₃.

1 26. The method of claim 17, further comprising depositing a CMP stop layer
2 after depositing the encapsulating non-magnetic layer for better CMP control.

1 27. The method of claim 17, further comprising depositing a write gap layer
2 of non-magnetic materials on the top of the write pole layer.

1 28. The method of claim 17, wherein the forming the trailing shield further
2 comprises forming a trailing shield photoresist, forming the trailing shield and lifting the
3 resist off.

1 29. The method of claim 17, wherein the forming the trailing shield further
2 comprises depositing a seed-layer on top of a write gap, plating the trailing shield and
3 removing exposed seed-layer.

1 30. The method of claim 17, further comprising depositing an overcoat over
2 the fourth stud segments and the trailing shield.

1 31. The method of claim 17, wherein the pole tip is laterally surrounded by a
2 non-magnetic material.